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AUTHOR Siemer, William F.
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ABSTRACT

This paper reviews the literature to outline principles and best practices for aquatic stewardship education. Stewardship education develops an internalized stewardship ethic and the skills needed for decision making and environmentally responsible actions. Successful stewardship education programs are designed to influence beliefs, values, intentions, action skills, and behaviors related to specific environmental issues. Programs should address entry-level, ownership-level, and empowerment-level variables associated with behavior change. These variables include environmental sensitivity fostered through outdoor experience, knowledge of ecology and aquatic environmental issues, personal investment in specific issues, knowledge and skills in environmental action strategies, internal locus of control, and intentions to take action. Stewardship education provides a set of sequential learning experiences over an extensive time period, in formal and nonformal settings, within a supportive social environment. Comprehensive teacher training is needed. Programs should incorporate family, peer, group, and community involvement. The instructor or teacher should act as facilitator or guide to the learner. Early outcome evaluation should focus on attitudes, as an indicator of progress toward behavior change in participants. A comprehensive approach to evaluation is recommended, with detailed formative evaluation preceding any summative assessments. Recommendations are offered for correcting common deficiencies in program evaluation and for future research. (Contains 99 references.) (SV)

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Best Practices For Curriculum, Teaching, and Evaluation Components of Aquatic Stewardship Education

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William F. Siemer
Cornell University

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Abstract – Stewardship education is a process designed to develop an internalized stewardship ethic and the skills necessary to make considered choices and take environmentally responsible actions. To be most successful, stewardship education programs should be designed to influence beliefs, values, intentions, action skills, and behaviors related to specific environmental issues. Programs should address the entry-level, ownership level, and empowerment level variables that have been correlated with behavior change. These variables include: environmental sensitivity; knowledge about ecology; in-depth understanding of aquatic environmental issues; a sense of personal investment in specific environmental issues; knowledge of environmental action strategies; skills in using environmental action strategies; an internal locus of control; and intentions to take action. Stewardship education should be viewed as a set of sequential learning experiences that take place over an extensive time period, in a combination of formal and nonformal settings, within the context of a supportive social environment. Comprehensive and extensive teacher training should accompany formal and nonformal programs. Programs should incorporate family, peer group, and community group involvement. The role of the instructor or teacher should be one of facilitator, or guide to the learner. Early outcome evaluation should focus on attitude research as a key to understanding whether progress is being made toward laying the groundwork for behavior change in program participants. Changes in the cognitive, affective, and conative components of attitudes should all be explored (i.e., examine outcomes such as change in knowledge, understanding, opinions, motivations, and behavioral intent). Stewardship education professionals should take a comprehensive approach to evaluation. That is, detailed formative evaluation should precede any summative assessments. Outcome evaluation should not proceed until it is clearly demonstrated that program design, implementation, and longevity are sufficient to expect particular behavioral changes. The author recommends that leaders in this field: (1) develop better indicators of program influences on attitudes, motivations, and behaviors; (2) establish a few long-term and longitudinal research projects associated with fully developed programs; and (3) conduct additional research on incentives and disincentives to engage in stewardship behaviors.

What Makes For Effective Stewardship Education?

A sound theoretical or conceptual framework is the best foundation for constructing and evaluating aquatic stewardship education programs. Literature-based definitions of stewardship and ethics-based stewardship education are needed to provide a conceptual structure from which the parameters of stewardship may be identified. Further, key assumptions underlying stewardship education programs need to be recognized so educational approaches that have shown promise as a means to achieve desired outcomes related to stewardship can be evaluated.

A Working Definition of Environmental Stewardship

Based on an extensive review of literature, Dixon et al. (1995:42-43) provided the following working definition of environmental stewardship. We believe this well-grounded and comprehensive definition provides a useful foundation for stewardship education programs.

Stewardship is the moral obligation to care for the environment and the actions undertaken to provide that care. Stewardship implies the existence of an ethic of personal responsibility, an ethic of behavior based on reverence for the Earth and a sense of obligation to future generations. To effectively care for the environment, individuals must use resources wisely and efficiently, in part by placing self-imposed limits on personal consumption and altering personal expectations, habits and values. Appropriate use of natural resources within the stewardship ethic involves taking actions that respect the integrity of natural systems.

It is important to recognize that the stewardship concept defined by Dixon et al. (1995) encompasses many basic values and may actually represent different

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ethical orientations across individuals. For example, some individuals and organizations may have an understanding of stewardship that is grounded in beliefs about the intrinsic values of fish and wildlife (Negra and Manning 1997). Other individuals and organizations ground their understanding of stewardship in beliefs related to utilitarian values of fish and wildlife (Negra and Manning 1997). Individuals involved in aquatic education programs may incorporate either perspective or a mix of both in their programs.

The reader also should note that, while many would agree that stewardship involves reverence toward the environment, they may disagree on the source of this reverence. For some, the source may be religious. For others, the source may be secular or spiritual (Negra and Manning 1997). Individuals involved in aquatic education programs may take very different approaches to developing a sense of reverence toward the natural environment.

A Working Definition of Ethics-based Stewardship Education

The Dixon et al. (1995) definition of stewardship includes terms such as ethics, morality, responsibility, and obligation. These terms reveal that aquatic environmental stewardship is a concept embedded within some system of ethics. Thus, in order to proceed with an analysis of best practices, one needs to establish working definitions of ethics and ethics-based stewardship education.

Frank Goble and David Brooks, who have been involved in character education programs developed by the Thomas Jefferson Center for Research, offer a useful working definition of the term ethics. They echo a definition provided by Albert Schweitzer and adopted by many others in the character education field: "In a general sense, ethics is the name we give to our concern for good behavior. We feel an obligation to consider not only our own personal well being, but also that of others and of human society as a whole" (Goble and Brooks 1983:iv; cited in "Common Sense and Everyday Ethics", Ethics Resource Center, Washington D.C., 1980). Educators and education program developers have used the terms ethics, morals, and character interchangeably to refer to the same concept: an internal system that determines correct behavior (Greer and Ryan 1989:26).

Proponents of character education believe that ethics, morals, and values provide guidelines for behavior. They believe that ethics, morals, and values show people the "path to become a good person" (Ryan 1993:16). What has variously been referred to as ethics education, moral education, or character education, is the process of teaching values and helping people develop the skills and experiences they need to solidify those values as internal guidelines for behavior.

It is important to recognize that many education scholars recognize teaching ethics, values, and morality as important and legitimate goals within formal education settings Education scholars have suggested that the goal of curriculum -- the set of ideas conveyed through formal education experiences -- is not just to teach something in a specific field or content domain (though that goal is embedded in most curriculum and may be primary in formal education settings). The goal of a curriculum also may be to: 1) produce well-adjusted adults; 2) produce "good" citizens; 3) or produce an ethical populace (Tyler 1949). In formal education, moral education has been defined as "what schools do, consciously and unconsciously to affect the way students think, feel, and behave concerning issues of right and wrong" (Greer and Ryan 1989:26). Ethical/moral education is not a new educational fad. "Character education is as old as education itself. Down through history, education has had two great goals: to help people become smart and to help them become good" (Lickona 1993:6).

Ethics-based environmental stewardship education may be considered a specific application of character education. It seeks to lay out a path of decisions and actions by which one may live an environmentally responsible life. Aquatic education programs may be designed to take on this educational challenge in a specific context -- enabling people to extend ethical considerations to their choices and actions as an angler or boater.

Wendell Berry (1987:7) wrote that nature "...is not only our source, but also our limit and measure." Understanding our choices, and how nature is both our limit and measure, enables humankind to choose appropriately in order to sustain both their humanity and nature, for the present and the future. Empowering learners to think critically– to understand the impacts and consequences of the choices they make, to choose the most right course–and to take appropriate action in implementing right choices ought to be the aim of aquatic stewardship education in a democratic society.

An ethics-based valuing of the environment, then, drives stewardship. In addition to developing critical thinking and decision-making skills, and empowering learners to take stewardship actions, aquatic stewardship education ought to include a consideration of the role ethics plays in supporting and underlying environmental stewardship.

We can conceptualize ethics-based stewardship education as a process of developing what have been described as ethical competence and ethical fitness. Quinnett (1994:117), suggests ethical competence involves certain skills, including the:

- Sensitivity to recognize a situation as posing one or more ethical considerations;
- Knowledge of what responses are legal versus what responses might be ethical in that situation;
- Willingness to act;
- Judgment to weigh various considerations where there are no laws or guidelines;
- Humility to seek consultation and additional knowledge to guide one's action.

According to Kidder (1995:57), ethical fitness is "a capacity to recognize the nature of moral challenges and respond with a well-tuned conscience, a lively perception of the difference between right and wrong, and an ability to choose the right and live by it."

In summary, we can define ethics-based stewardship education as a process designed to develop an internalized stewardship ethic and the skills (i.e., critical thinking; decision-making; ethical competence; ethical fitness; and action skills) necessary to make considered choices and take environmentally responsible actions. Ethics-based stewardship education should provide internal guidelines for responsible behavior toward the natural world in a variety of situations that one might encounter in everyday life. Ethics-based aquatic education is intended to develop internal motivations and guidelines for responsible behavior toward other people and their activities while one is engaged in some aspect of fishing or boating (Matthews and Riley 1995). As an ultimate goal, aquatic stewardship programs should strive to develop internal guidelines that will later serve as a foundation for responsible behavior toward the natural world in a variety of situations that one experiences beyond the specific contexts of fishing or boating.

Education Approaches Likely to Achieve Desired Outcomes

The literature identifies a number of characteristics of stewardship education programs that appear to be most promising as vehicles to stimulate environmentally responsible behavior. Exploring what researchers have found with regard to curriculum content, teaching methods (delivery), and activities suggests a number of criteria for guiding aquatic stewardship education practices.

The field of environmental education has long recognized the importance of the interplay of awareness, values, attitudes, knowledge and responsible environmental behavior but, as we have noted, has been hampered by reliance on inaccurate models. Until the 1980s there was no comprehensive, useful summary of the large body of environmental education research. Then, a rigorous meta-analysis of this research, conducted by Hines et al. (1987) provided some breakthroughs in environmental education theory and practice, and a more grounded basis for environmental education policy initiatives. These researchers came to 3 important conclusions:

1. Developing awareness and ecological knowledge is not enough to cause long-lasting behavior changes.
2. Ownership – developing a personal connection with and knowledge of issues is critical to responsible environmental behavior.
3. Instruction that focuses on ownership and empowerment (a sense of being able to make changes and resolve important problems, and use critical issues investigation skills to do so) changes behavior (Hungerford and Volk 1990).

Hungerford and Volk (1990) extended the work of Hines et al. (1987) by identifying three categories of variables that contribute to environmentally responsible behavior and suggesting that these variables operate in a linear or progressive fashion (Figure 1). Following the work of Hines et al. (1987), Hungerford and Volk (1990), and Knapp et al. (1997), these variables are labeled: 1) entry-level variables; 2) ownership variables; and 3) empowerment variables. Entry-level variables, according to Hungerford and Volk (1990), are good predictors of behavior or ones that appear to be related to responsible citizenship. They include environmental sensitivity and knowledge about ecology.

Ownership variables personalize environmental issues, creating individual ownership of the problem or issue. Ownership variables appear to be critical to responsible environmental behavior (Hungerford and Volk 1990). They include an in-depth understanding of the issues and personal investment in and identification with the issue.

Empowerment variables give human beings a sense that they can make changes and help resolve important environmental issues (Hungerford and Volk 1990). Empowerment variables include perceived skill in using environmental action strategies and skills, knowledge of action strategies, an internal locus of control, and the intention to act. Hungerford and Volk assert that a progression exists from entry level through empowerment,

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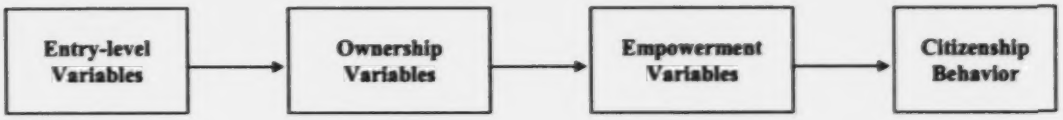
Figure 1. Major and Minor Variables in Environmentally Responsible Behavior.



Major Variables	Major Variables	Major Variables
Environmental sensitivity	In-depth knowledge about issues	Knowledge of and skill in using environmental action strategies
	Personal investment in issues about the environment	Locus of control (expectancy of reinforcement)
Minor Variables	**Minor Variables**	**Minor Variables**
Knowledge of ecology	Knowledge of the positive and negative consequences of behavior	In-depth knowledge about issues.
Androgyny	Personal commitment to issue resolution	

Source: Hungerford and Volk 1990.

and that pro-environmental behavior will be more likely if all three levels of variables are included in an education program. They also recognize that this process takes place over time, may call for sequentially, complementary education efforts, and may work best when learning occurs in a combination of formal and nonformal learning environments (Hungerford and Volk 1990).

The variable that Hines et al. (1987) labeled "environmental sensitivity" is of special interest to developers of programs that incorporate outdoor experiences. Environmental sensitivity refers to an increased level of empathy toward the natural environment. Studies suggest that environmental sensitivity is developed through significant, positive contact with the outdoors over a long period of time (Chawla 1998, 2000). For example, research into significant life experiences (Tanner 1980; Peterson 1982) supports the notion that adults exhibiting conservation leadership and involvement in environmental careers share a common set of experiences involving the outdoors and outdoor activity, such as fishing, when youngsters. Frequently, these experiences included adult family members and significant others from the youngsters' social world that were available to guide and mentor them.

Kellert (1987) offered a possible explanation for the association between outdoor experiences and environmental sensitivity. He suggested that "a personally meaningful environmental ethic requires a fundamental sense of affection for and identification with nature, and a related capacity to perceive oneself as an integral and obligate member of the ecological community; and ... unethical behavior is often associated with feelings of alienation ...from nature, allowing oneself to abuse and exploit the biota for various egoistic needs and immediate gratifications divorced from feelings of personal

guilt or long-term responsibility" (Kellert 1987:19). Fishing is one outdoor activity that may develop the deeply personal connection with nature that Kellert (1987) suggested is needed to counter alienation and apartness leading to unethical behaviors. Further, Hungerford and Volk (1990) suggested that if these research studies are to help us make educational decisions about developing environmental sensitivity, it seems important that learners have environmentally positive experiences in nonformal outdoor settings over long periods of time.

Hungerford and Volk (1990) identified a research support base for 6 critical educational components that, when implemented, can maximize behavioral change (Table 1). Their focus on including action components in the curriculum in order to affect behavior is supported by several studies conducted at Southern Illinois University (Culen and Volk 2000, Klinger 1980, Ramsey 1987, and Simpson 1989). According to Weigel (1985:75) effective behavioral change occurs when "in addition to providing knowledge about an issue, information (is also) made available regarding both the type of action implied by that knowledge and specific guidance as to how to carry out that type of action." The specificity of the behavioral message is critical to effecting behavioral change (Weigel 1985). Howe and Disinger (1988) found that the demonstration of responsible environmental behavior is linked to long-term student involvement with environmental issues. To reach this point, Howe and Disinger (1988) suggested that learners need to have knowledge of ecological concepts, knowledge of the environmental issues involved, concern for the quality of the environment, knowledge of effective action strategies, a belief in their ability to make a difference, the commitment to act, and actual experience in action-oriented activity.

Hungerford and Volk's (1990) work offered an important advance in program design. Many of the environmental education programs developed in the 1960's and 1970's were based on a "hypodermic needle" model of communication (Winett 1992). In this model, the audience simply receives "inoculations" of information, and then is supposed to act in relatively predictable and desirable ways. Communication research has shown this approach to be overly simplistic and largely ineffective (Stern 1992), though some studies suggest that youngsters exposed to formal environmental education are more inclined than a control group to demonstrate

Table 1. Critical Components of Environmental Behavior Change Programs.

"It appears that we can maximize opportunities to change learner behavior in the environmental dimension if educational agencies will:"

1. Teach environmentally significant ecological concepts and the environmental interrelationships that exist within these concepts;
2. Provide carefully designed and in-depth opportunities for learners to achieve some level of environmental sensitivity that will promote a desire to behave in appropriate ways;
3. Provide a curriculum that will result in an in-depth knowledge of issues;
4. Provide a curriculum that will teach learners the skills of issue analysis and investigation as well as provide the time needed for the application of these skills;
5. Provide a curriculum that will teach learners the citizenship skills needed for issue remediation as well as the time needed for the application of these skills; and
6. Provide an instructional setting that increases learner's expectancy of reinforcement for acting in a responsible way; i.e., attempt to develop an internal locus of control in learners.

Source: Hungerford and Volk 1990.

pro-conservation behavior (Asch and Shore 1975; Leeming et al. 1993). The simple hypodermic needle model of communication fails when there are competing sources of information, when information is not well-crafted, when information is difficult to act upon, in unusual or less controlled situations (as in informal communications), or when issues are complex (Winett 1992). These descriptors frequently apply to aquatic resources education settings, casting doubt on the efficacy of this simple communication model for fishing and boating education programs with a stewardship action agenda.

Social Context

Educational programs designed to change behaviors also should consider the social context surrounding the environmental issues of interest (Laska 1990). Program designers should view the desired behavior changes within the context of the worldview shared by those involved with or affected by the issue. Developing programs that consider the salient social may enhance the likelihood of producing target behaviors and cultural norms in the community served by the program.

The literature on character, morals, ethics, and values education clearly establishes the importance of understanding the influence of social context on the success of the educational effort (Leming 1993a, 1993b; Matthews and Riley 1995). In stewardship education, the social context in which the education takes place is at least as important as the methodology by which stewardship concepts are taught. If not grounded within the particular community and cultural context of the learner, stewardship education will remain abstract, outside the scope of experience of the learner, inconsistent with cultural norms, and ultimately irrelevant (Berger and Neuhaus 1977; Hauerwas 1981; Sichel 1988).

Belonging to and identifying with a group is important for an individual's personal development. Researchers have identified group and community as important variables in the development of ethics and values (Hauerwas 1981). Community can include family, school, ethnic community and groups to which one belongs, such as 4-H or Girl Scouts (Sichel 1988; Berger and Neuhaus 1977). Family, peers, and others in the community transmit their attitudes, beliefs, and values to participants in aquatic stewardship programs. Group members positively influence or actually initiate an individual into activities like fishing and boating, and can encourage or discourage stewardship behaviors associated with those activities (Dann 1993, 1998).

This suggests that to be most effective, stewardship education programs should use small groups, emphasize peer activities, focus on relevant issues, and involve action learning. Mentoring, community clubs, and family programs implemented over the long term may build the kinds of moral communities that we know will facilitate ethics education (Matthews and Riley 1995). Aquatic stewardship programs will be most effective in reaching behavioral goals if designed to incorporate parents, family, and neighborhood as part of the learning community.

Stewardship Incentives and Barriers

Dwyer et al. (1993) reviewed the research completed during the 1980's dealing with behavioral change related to the environment as a result of interventions designed to effect that change. They found that "antecedent conditions using commitment, demonstration, and goal-setting strategies were generally most effective in encouraging environmentally responsible behavior, and consequence conditions were effective in producing behavior change during the experiment's duration" (Dwyer et al. 1993). They also noted that little comparison of interventions had occurred, the little follow-up research that did occur found that the behavioral changes were generally not maintained, and many potentially effective intervention strategies have been ignored (i.e. group interventions and penalties) (Dwyer et al. 1993).

Many of the intervention strategies and behavior-change techniques described by Dwyer et al. (1993) may be of interest to stewardship educators. They grouped these strategies into two major categories, antecedent conditions and consequence conditions. The antecedent conditions include passive, active, individual, and group techniques intended to encourage target behaviors. The studies reviewed by Dwyer et al. show that prior commitment to conserve consistently resulted in behavior changes persisting over follow-up measures of up to 12 weeks (Dwyer et al. 1993). Some strategies that may be effective include:

- Getting the learner to commit to doing some target behavior.
- Getting the learner to select a personal or team goal related to a target behavior.
- Engaging the learner in-group competition related to a target behavior.

Some programs also use oral or written "activators" to prompt conservation behaviors. Dwyer et al. (1993:291) found "little convincing evidence that even intensive mass media campaigns promoting conservation have had appreciable effects." This finding is consistent with the notion that information alone is not enough to change behavior.

Some researchers have found that feedback, rewards, and penalties can produce short-term behavior change. However, when these consequence conditions are removed, people immediately return to their original behavior patterns (i.e., they stop participating in the target activity). As Dwyer et al. (1993:304) stated, "The challenge remains to encourage behavior maintenance." These studies suggest that feedback, rewards, and penalties may have some promise for stewardship education programs, but by themselves, they are not likely to produce lasting behavior change or development of environmental citizenship.

In the research examined by Dwyer et al. (1993), no studies were found examining individual or group goals where the subjects were involved in setting the goal. This is unfortunate in light of the promise this type of method appears to hold in the outdoor ethics education arena (Leming 1978, 1993a, 1993b; Matthews and Riley 1995).

A summary of literature by Gray et al. (1985) generally found that external strategies, such as financial incentives, were effective in changing behavior, though some evidence suggests the change was short-term. Persuasive communications that provided information alone were not enough to effect change. Of real interest to stewardship educators is evidence supporting norm-activation as a strategy for influencing behavioral change (Schwartz 1977, cited in Gray et al. 1985). The importance of the group context in influencing norms has also been stressed (Stern 1978, cited in Gray et al. 1985).

Stewardship incentives or barriers/constraints may encourage or discourage environmental stewardship actions. Behavioral incentives or barriers may be cultural, psychological, economic, political, or socio-demographic in nature (Dixon et. al. 1995).

Constraints might be: intrapersonal (not feeling able to perform the behavior, lacking skills or confidence), interpersonal (not having someone to do the behavior with, having someone who is discouraging them from taking part), or structural (lack of time or money, lack of access to a site to perform the behavior). Additional barriers may be cultural, political, or socio-demographic (Dixon et. al. 1995). Environmental educators must seek to understand and identify these constraints and design aquatic education programs to minimize or even eliminate such barriers.

Teachers, Teacher Training, and Teaching Methods

A number of researchers have provided evidence that teaching styles and methods are important to the success of environmental education programs. Hungerford and Volk (1990) stressed that teachers who are positive role models can increase the likelihood of desired stewardship outcomes. Ramsey and Rickson (1976) provided evidence that teaching methods/strategies, behaviors, and leadership styles are important variables in the learning process. May (2000) provides evidence that teachers themselves believe these elements to be critical to successful environmental education.

Perhaps the most difficult challenge facing the stewardship educator is creating the basis for long-term behavior change based on an internalized stewardship ethic. As has been mentioned earlier, this is essentially an exercise in character education. The role of the teacher, and the type of interaction he or she has with students, is critical to the effective character education process (Leming 1993a, 1993b).

Much more research is needed before a comprehensive theory of effective character education will emerge (Leming 1993b), but researchers evaluating the outcomes of drug, alcohol, and violence prevention programs have documented the effectiveness of some approaches to character education. The following practices and strategies have proved to be ineffective in producing target behavior changes in youth program participants: lecturing and moralizing; use of charismatic hero figures to lead and inspire; use of authoritarian teachers/leaders; codes of ethics derived by adults or others outside the peer group; and values clarification (Leming 1978, 1993a, 1993b). However, some approaches have proved more effective in changing learner behavior. These include: small group settings where learners participate in setting their own as well as the group's learning agenda; peer guidance and peer counseling approaches; peer group activities involving problem solving and developing group norms and codes of behavior; focusing on behavioral issues of relevance within the cultural context of the learners and their communities; creating positive and mutually respectful learning climates; and establishing adults as participant-learners and guides in the ethics education process (Leming 1978, 1993a, 1993b).

Damon (1993:1) suggested, "The enterprise of teaching children values in school is often an indirect one. Where core values are concerned, teachers often communicate more by their manners than through explicit messages." Clifford Knapp, in his book *Lasting Lessons*, emphasized the importance of teachers as guides who help learners reflect on their experience, to make the learning experience more meaningful. By reflecting on the experience of, say, an angling ethics education exercise, the meaning of the experience be-

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comes that much more personal and relevant, and ultimately more powerful and long lasting. Knapp noted that educators are just beginning to understand the value of constructing the meanings and interpreting the connections inherent in experience and that real learning requires meaning-making (Knapp 1992).

Fortner (1991) suggested that teacher training is a must to assure the highest level use of curriculum materials. Evaluation of programs, such as Project Wild, document that curriculum materials go unused unless supported with in-depth in-service training for teachers (Paul and Burde 1997). Without training in use of curriculum materials or recommended teaching strategies, teachers may not be able to achieve many of the goals or objectives of a stewardship education program.

The environmental education community is in substantial agreement that lack of teacher training is a common cause of program failure (UNESCO 1997), but this recognized deficiency remains a persistent problem within the U.S. and throughout the world. Knapp (2000) urges the environmental education community to adopt extensive teacher training as the cornerstone of environmental education. Those interested in aquatic stewardship education would do well to adopt Knapp's recommendation.

Temporal and Contextual Factors

The education literature also suggests that stewardship education programs sustained over time are the most likely to create long-lasting program outcomes. Studies suggest that if stewardship behavior is to be maintained there must be follow-up support to help maintain it. Behavioral change research points very clearly to the fact that, even when strong short-term behavioral change occurs, the prognosis for long-term change is highly doubtful without continued application and reinforcement of the intervention strategy (Dwyer et al. 1993, Hungerford and Volk 1990). According to Hungerford and Volk (1990:14), "In light of Ramsey's follow-up study, it seems obvious that learners need to be reinforced for positive environmental behavior over time. ...it is evidently imperative that learners get in-depth educational experiences over a substantial amount of time." Some educators recommend that stewardship education programs contain a set of stewardship apprenticeship experiences that the learner shares over a sustained period of time with a personally significant person.

Contrary to Hungerford and Volk's (1990) recommendation, most contemporary environmental education seems to take the form of short-term program modules or individual lessons. In an international conference celebrating the 20th anniversary of the Tbilisi Doctrine on environmental education (TICEE 1978), more than 1,000 educators reaffirmed the notion that such piecemeal approaches need to be replaced with in-depth and sustained programs.

> *"...those short-and sweet strategies have negated the use of more substantial models that encourage long-term issue investment and, most important, long-term thinking and responsible citizenship behavior on the part of students."* (Knapp 2000:34).

To be effective, aquatic stewardship education has to cut across formal and nonformal learning contexts, as well as occurring across a span of time. Knapp (2000) urges schools and non-government organizations to partner to achieve effective environmental education.

> *"The ultimate aim of environmental education cannot be accomplished alone. In particular, we must begin to find new and better ways to combine formal environmental education efforts with those of nonformal environmental education. The similarities between them require that the success of either depend on partnerships."* (Knapp 2000:36)

Environmental stewardship means accepting personal responsibility for how one's actions affect aquatic environments and taking actions (i.e., expressing behaviors) that reflect the existence of an ethic of personal responsibility. Ethics-based stewardship education is a process designed to develop an internalized stewardship ethic and the skills necessary to make considered choices and take environmentally responsible actions. Ethics-based stewardship education is a specific type of character education, and as such, involves teaching people how to behave toward aquatic environments. The ultimate aim of aquatic stewardship education, and environmental education generally, is to develop environmentally responsible citizens.

Developing environmentally responsible citizens requires more than raising awareness, knowledge, and concern about the environment. To be most successful, stewardship education programs should be designed to influence beliefs, values, intentions, action skills, and behaviors related to specific environmental issues. In other words, programs should address the entry-level, ownership level, and empowerment level variables that have been correlated with behavior change. These variables include: environmental sensitivity; knowledge about ecology; in-depth understanding of aquatic environmental issues; a sense of personal investment in specific environmental issues; knowledge of environmental

action strategies; skills in using environmental action strategies; an internal locus of control; and intentions to take action.

The challenges of this kind of change process are too great to be addressed by any single person or program. Program developers should view this as a process that occurs over an extensive period of time, through sequential learning experiences that take place in a combination of formal and nonformal settings, within the context of a supportive social environment. Continued applications and reinforcement are necessary to produce long-term behavior change. Continued, sequential programming also can increase the probability of desired behaviors if those programs increase the incentives and reduce the barriers to short-term behavior change. Program developers should keep in mind that school-based stewardship programs are unlikely to be adopted or utilized effectively unless supported with comprehensive and extensive teacher training. Training should be an integral part of nonformal stewardship programs, as well.

The social context of stewardship education is especially important, because family and community play such a significant role in the development of values and ethics. To be most effective, stewardship education programs should incorporate family, peer group, and community group involvement with an eye toward developing a supportive moral community where a stewardship ethic can be nurtured and developed over time. The role of the instructor or teacher should be one of facilitator, or guide to the learner.

Recommendations for Stewardship Education

The need for evaluation of new and existing environmental education programs is widely recognized (O'Hearn 1982, Lucko et al. 1982). For example, in a paper titled *Setting the Agenda for Outdoor Ethics Education*, Bruce Matthews and Cheryl Riley made the following statement.

> *...the methods or strategies developed and used for outdoor ethics education all too frequently are based not on research evidence supporting their effectiveness, or even on critically accepted education theory, but on what another program or agency is doing. Only in a very few instances have attempts been made to evaluate outdoor ethics education efforts, and these have not supported the effectiveness of the ethics education approach used (Bromley et al. 1989, Jackson and Norton 1979). In this day of accountability, we must be able to show evidence that our outdoor ethics education efforts are effective and based on sound educational theory. When we do less, we do a disservice not only to those we are attempting to educate but to the resource, the outdoor activity and to ourselves.* (Matthews and Riley 1994:592)

A myriad of activities and curricula have been developed for formal and informal teaching applications, but few of these programs have been formally evaluated with regard to goal achievement, knowledge gains, or changes in attitudes or behavior. For example, a national survey of environmental educators about 20 years ago (Disinger 1981) found about 7% of K-12 environmental education programs had been subjected to a formal program evaluation, 43% had been evaluated informally, and 50% had not been evaluated at all. Some notable exceptions to this trend exist, of course. Project WILD, for example, has enjoyed a comparatively large amount of attention from evaluators. Yet, it is reasonable to say that program evaluation remains uncommon two decades after Disinger's survey of educators.

Implicit in a discussion of guidelines for evaluation of aquatic stewardship education programs is an acknowledgment of gaps in evaluation methods and applications. Some of the key gaps in understanding are summarized in Table 2. Table 2 could be much longer, given that so little evaluation of stewardship programs has gone beyond simple description of program activities and numbers of program participants. All of the practices recommended earlier are supported to some degree in the environmental education literature, but the application of those ideas in aquatic stewardship programs has not been examined extensively within the context of carefully designed studies.

Take a Comprehensive Approach to Evaluation

Too often, the task of program evaluation is reduced to a summative judgment of whether desired outcomes were achieved. This kind of summative evaluation is useful but incomplete. As an overall recommendation, stewardship education professionals should take a comprehensive approach to evaluation (Decker 1990). By comprehensive, evaluation that includes detailed formative evaluation in advance of any summative assessments is needed.

A comprehensive approach allows one to answer four questions:

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Table 2. Summary of Gaps in Information about the Effectiveness of Recommended Practices for Aquatic Stewardship Education Programs.

Topic Area	Research Questions in Need of Greater Attention
Knowledge	To what degree do increases in knowledge contribute to changes in learner behavior?
Attitudes and behavior	To what degree do positive attitudes toward the environment and aquatic resources contribute to expression of environmentally responsible behavior?
Attitudes and behavior	Under what conditions does expression of stewardship behavior serve as feedback to influence stewardship attitudes?
Attitudes and behavior	Are there specific attitudes that are associated with expression of environmentally responsible behavior?
Attitudes and behavior	What attitudes are activated in particular aquatic stewardship situations, and what attitudes are used by the actor to make decisions and take actions?
Norms	Does norm activation within stewardship programs influence learner behavior?
Motivations	What motivates boaters and anglers to engage in specific types of environmentally responsible behavior?
Antecedent conditions	What types of incentives and rewards encourage specific desired environmentally responsible behaviors?
Consequence conditions	What types of disincentives and penalties encourage specific desired environmentally responsible behaviors?
Intentions	How does perceived locus of control and perceived responsibility influence intention to take environmentally responsible actions?
Social support	Are stewardship programs that include family and peer groups more likely to produce desired stewardship behaviors than programs without family and peer group involvement?
Apprenticeship experiences	Are stewardship programs that include apprenticeship experiences with mentors more likely to produce desired stewardship behaviors than programs without an apprenticeship component?
Apprenticeship experiences	How many apprenticeship experiences, over what period of time, are needed to produce long-term expression of environmentally responsible behavior by angers and boaters?

1. Was the underlying program model faulty?
2. Was the implementation of the program model appropriate and carried out as prescribed?
3. Were expectations of outcomes/impacts unrealistic, therefore unattainable?
4. Was the evaluation itself adequate in terms of methods, impact indicators examined, people contacted, etc. to obtain valid, reliable, and programmatically meaningful information? (Decker 1988:19).

Questions one through three above can be addressed through a process called an "evaluability assessment" (Smith 1989). Examples of evaluability assessments related to stewardship education programs are provided by Siemer and Brown (1997, 1998), and Siemer et al. (1998). An evaluability assessment is a thorough examination of a program and its elements. Done well, it will reveal much about the plausibility a program has as a vehicle to produce desired stewardship outcomes. It identifies needs that must be addressed before more extensive evaluation can be conducted efficiently and effectively. For example, an evaluability assessment will clarify the degree to which local programs have been implemented as planned (this is sometimes referred to as "implementation fidelity). Evidence of poor implementation fidelity raises questions about the plausibility of reaching program goals. A finding of poor implementation fidelity should tell evaluators that additional evaluation steps would be inefficient until program implementation is improved.

Develop a Better Understanding of Attitude – Behavior Linkages

For the past 25 years, researchers and practitioners in environmental education, environmental behavior, social marketing, and human dimensions of fisheries and wildlife management have been examining factors which contribute to the development of responsible environmental behavior (Stern 1992). This notion of stewardship is built on the assumption that "the ultimate aim of education is shaping human behavior" (Hungerford and Volk 1990:8). Yet, these researchers recognize that the factors contributing to stewardship behaviors represent a complex web of interlinked precursors. Researchers have found evidence associating environmental behavior with antecedents that include: attitudes, locus of control, knowledge, sense of responsibility, social norm, environmental sensitivity, and behavioral intentions (Hwang et al. 2000).

Because of the complexities associated with educating and evaluating in this domain, researchers have been examining quantitative measures (i.e., indicators) of behavioral and other changes to provide clues as to the effectiveness of stewardship and environmental education (Dixon 1996; Dixon et al. 1995; Matthews & Riley 1995; Siemer et al. 1995). The following subsections examine the relationship between behavior and other factors such as attitudes, motivations and intentions, and reviews several broad categories of indicators that others have used to assess outcomes from environmental education programs. Advances in the field of stewardship program evaluation are dependent upon improved measurement of indicators in all of the categories discussed below.

Attitudes and Behavior

For the purpose of examining the concept of aquatic stewardship, it is useful to conceptualize an attitude as an underlying disposition entering into the determination of a variety of behaviors toward an object or class of objects (Weigel 1985). Social psychologists have suggested that attitudes consist of three components: cognitive (beliefs, facts, principles, knowledge, or understanding); affective (emotion, feeling, or emotional evaluation); and conative (behavioral tendency or intent) (Weigel 1985).

Embedded in the field of environmental education is an operating assumption that greater environmental understanding will contribute to positive changes in learner behavior. Although this assumption has driven environmental education for decades, an empirical basis for this relationship is still developing and merits a great deal more research attention.

While some psychologists (e.g., Festinger 1957, Fishbein and Ajzen 1975, Azjen and Fishbein 1980) have collected data to support the theory that "actions flow from attitudes" (Weigel 1985:72), others (e.g., Bem 1972) have collected data to support the theory that overt behavior promotes the development of internalized attitudes. Weigel (1985) states that contemporary research suggests a reciprocal relationship between attitudes and behavior. This means that programs intended to influence environmental attitudes or behavior have the potential to influence both, and both should be considered in the process of developing educational interventions. This reciprocal relationship should be explored within the specific context of aquatic stewardship education programs.

Changing Behavior

Actual behavior change is the ultimate aim of environmental education generally (Hungerford and Volk 1990) and aquatic stewardship education specifically. Creating behavior change, however, especially the long-term changes sought as evidence of successful stewardship education, is a tall order. Early research in outdoor and environmental education often made the assumption that changing an individual's knowledge of and concern about an environmental issue would produce attitude change, which in turn would result in more environmentally responsible behaviors by environmental program participants. Environmental education research generally has provided weak evidence of the assumed links between environmental understanding, attitudes, and environmentally-responsible behavior (Brown and Manfredo 1987; Borden and Schettino 1979; Dwyer et al. 1993; Fortner and Mayer 1983; Gigliotti 1992a; Hines et al. 1987; Hungerford and Volk 1990; Kellert 1992; Marcinkowski 1989; Ramsey and Rickson 1976; Rokeach 1972; Sia et al. 1986; Sinden and Worrell 1979; Sivek 1989; Zelezny 2000). In this regard, the experience of environmental education researchers has been no different than that of social psychology researchers more generally. Since the 1930's, multiple researchers (e.g., LaPiere 1934; Kiesler et al. 1969; Wicker 1969) have completed studies that show only a weak association between opinions and actions. These findings prompted serious concerns about the usefulness of attitude research and the influence of attitudes and attitude change on behavior (Weigel 1985). However, more recently, researchers have provided evidence that certain attitudes can serve to support and possibly even predict certain environmental behaviors (Hines et al. 1987; Borden & Schettino 1979; Marcinkowski 1989; Sia et al. 1986; Sivek 1989; Stern 1992).

Attitudes can be used to predict behavior more con-

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sistently if the researcher takes measures to account for the social, psychological, and situational variables known to influence expression of behavior (Ajzen and Fishbein 1980, Fishbein and Manfredo 1992). At least six factors have been identified that influence behavioral expression of attitudes: specificity, intentionality, ambiguity, level, vested interest, and self-monitoring (Crano and Messe 1982). It is reasonable to assume that these influences will operate on participants in boating and fishing education programs, but those assumptions need to be examined through controlled studies of actual programs.

Specificity refers to "matching the degree of specificity of the measured opinion with that of the potential behavioral expression of the opinion" (Crano and Messe 1982:194). For example, Weigel (1985) cited evidence that highly focused attitude measures will yield more accurate predictions of the occurrence of specific actions. The key to increasing predictive power appears to be linked to the specificity of both the attitude measured and the behavior observed. Intentionality refers to including some measure of the respondent's intention to take the behavior of interest (Crano and Messe 1982). Extensive work by Fishbein and Ajzen (1975) has shown that information about the respondent's intentions to act can increase the ability to predict behavior. Hwang et al. (2000) provided some evidence that measuring intentions can indeed help predict whether learners will demonstrate environmentally responsible behavior. Ambiguity refers to the respondent's personal experience with people, objects, or events in the behavioral setting (Crano and Messe 1982). Direct personal experience reduces ambiguity and thus increases the likelihood that expressions of attitude about a particular behavior will have predictive power. For example, direct experience with aquatic environmental issues like water pollution and habitat loss would be expected to reduce ambiguity in attitudes toward those issues. This relationship should be explored in stewardship program evaluations.

Level refers to the centrality of beliefs associated with a given attitude (Crano and Messe 1982). Central beliefs are more likely to influence behavior than are attitudes based on beliefs that are more peripheral. Central beliefs (and values) also are long lasting and difficult to change through education programs. Though stewardship education programs are not designed to change central beliefs, program evaluators can understand more about participants' attitudes and behavior if they make some effort to assess participant belief systems.

Vested interest refers to the extent to which a person perceives an opinion to be associated with his or her well-being. The greater the perceived vested interest of one's opinion, the stronger the link between that opinion and one's overt action (Crano and Messe 1982). For example, one would expect that a child's attitudes about an environmental issue on a local water body are more likely to influence and predict her behavior on or around that water body if she has a vested interest in that resource (e.g., if she is aware that her drinking water comes from that source, or if she values that water body as a personal boating or fishing destination).

Self-monitoring refers to the extent to which a person uses feedback from the social context as an indicant of the appropriateness of his or her actions (Crano and Messe 1982). This is a personality trait that varies by individual. Instruments have been developed to assess this trait, but it may not be subject to direct influence through stewardship education programs.

Shapiro (1994) noted four requirements for attitudes to influence behaviors. Attitudes must be:

- Available (i.e., the subject possesses an attitude)
- Perceived as relevant to the behavior
- Accessible (i.e., attitude must come to mind when making decision about behavior)
- Actually used to make the decision.

Shapiro believed that most environmental educators and researchers at that time had concentrated primarily on availability, on giving knowledge that leads to the availability of attitudes. He agreed with Gray et al. (1985) that more research was needed to identify which specific attitudes actually determine behavior, which attitudes are likely to be used in a given situation, and what influences the attitudes that are used.

Develop Better Indicators of Program Outcome Behavior Change

Behavioral indicators of aquatic stewardship may range from simple verbal expressions of awareness of fisheries biology concepts, to enduring and complex expressions of commitment to aquatic resources. If stewardship behavior is the desired outcome of a program, those indicators involving the long-term demonstration of desirable behaviors offer the best evidence of successful programming (Matthews & Riley 1995).

There are many potential behavioral indicators of an internalized stewardship ethic. Deep involvement in the culture and social world related to fishing, and participation in opportunities to have input to fisheries management decisions may indicate an underlying stewardship ethic (Hungerford and Peyton 1980). Other potential indicators include: membership and activity in

environmental organizations, personal decisions regarding family size, volunteer service, political activity, product purchasing and disposal, food consumption patterns, water use and conservation practices, household waste disposal, lawn and garden practices, and energy usage and conservation (Dixon et al. 1995). Choosing a career related to natural resources or the environment may also provide a behavioral indicator of an internalized stewardship ethic. Youth who participate in fishing and boating education programs may demonstrate an internalized stewardship ethic through activities such as catch-and release fishing, cleaning up litter in the places they boat, participating in stream habitat improvement projects, or changing the way they use water at home and school.

It is important to note that evaluation of behavior change should be linked to program goals and program elements oriented toward modifying specified categories of behavior. Evaluation of specific types of behavior change may be inappropriate within the context of a program that had no specific goals related to behavior and contained no specific program elements related to the intended behavioral modification.

Motivations

A long-term goal of environmental education is to develop citizens who make choices and take actions based on an internalized stewardship ethic. If we want to obtain information about the development of a stewardship ethic, information on behavioral motivations will be needed. For example, as evaluators, we might observe a young boater picking up a discarded motor oil container alongside a lake. Clearly this is an appropriate expression of stewardship behavior, but unless we assess her motivations, we will have no indication that a stewardship ethic influenced her action. While it is true the youngster is demonstrating good behavior, she may be doing it because she wanted to impress someone watching her, she'd been told to do it, she was in a competition to see who could pick up the most litter, she wanted something to play with, or any number of other motivations which may be completely unrelated to stewardship.

Assessing motivation is a complex process, but may be guided by the use of an appropriate theoretical model (Deci and Ryan 1985). Stewardship behaviors may be internally or externally motivated. External motivations include financial, legal or normative (peer/social pressure, community norms, etc.) incentives and disincentives. Externally motivated actions are motivated by a desire to avoid a consequence/penalty or gain a reward. Awareness, knowledge, values and ethics may serve as internal motivators. Measures of stewardship motivation have focused on both external and internal sources, including: key values and beliefs, perceived responsibilities, awareness and knowledge, expected environmental benefits, legal sanctions, time and money penalties, information sources, locus of control, and environmental concern (Dixon et al. 1995).

Intentions

Stewardship intentions are "the extent to which people express commitment to responsible stewardship" (Dixon et al. 1995:27). Frequently, intentions are measured by assessing "individuals' willingness to devote money, time, or political support" (Dixon et al. 1995:27). Hines et al. (1987) developed a model of factors that influence responsible environmental behavior based on a synthesis of 128 studies of attitude and behavior change related to the environment. In addition to the requisite knowledge, attitudes and action skills, Hines et al. (1987) included a number of personality factors leading to the intention or desire to act. These include attitudes toward the environment and toward taking action, locus of control, and personal responsibility.

Establish Long-term Evaluation Projects That Include Experimental Designs

As noted earlier, evaluation of environmental education programs generally and stewardship programs specifically remains the exception rather than the rule. Moreover, when evaluation is conducted it tends to be for administrative purposes and it generally examines programs "as is." Practical constraints make it very difficult to use an experimental or quasi-experimental research design. For example, the researcher generally does not have the opportunity to manipulate variables like teacher training, curriculum materials, or field experiences. It is rarely possible for the researcher to randomly assign program participants to treatment groups or to create different treatment groups a priori. Such constraints are to be expected, but they represent a major impediment to the advancement of knowledge about effective program design. To overcome this impediment, leaders in the field of stewardship education should take steps to establish a few long-term research projects designed explicitly to explore research questions. These pilot projects should establish funding for multi-year evaluation that utilizes experimental or quasi-experimental research designs (e.g., random assignment of youth to treatment groups; experimental manipulation of program content).

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Develop Authentic Assessment Procedures

The prospect of outcome evaluation may conjure an image of standardized testing procedures. However, the author encourages stewardship educators to consider developing authentic assessment procedures as an alternative and supplemental set of approaches to assessing knowledge and skills gains in formal and informal learning settings. Moorcroft et al. (2000) identify several useful approaches, including portfolio assessment (i.e., an assessment of student-developed materials collected at regular intervals over an extended period of time) and essay assessment (i.e., posing a complex question or set of simpler nested questions that prompt the student to explore various aspects of a topic), and performance assessment (i.e., various techniques that prompt the student to apply knowledge and skills in a realistic setting or situation). These approaches to evaluation are time consuming and can be expensive to implement. However, authentic assessment will allow the evaluator to: 1) document changes in skill and knowledge for individual learners; 2) identify program areas in need of improvement; and 3) verify notions of what students will learn from various program experiences (Moorcroft et al. 2000).

Summary

The ultimate aim of ethics-based stewardship education is "observable change in behavior that is due to internal motivations based on ethics" (Matthews and Riley 1995:10). The best indication that a program is successfully producing intended behavioral outcomes is a quantitative assessment that shows youth who participate in a program have a higher propensity than other youth to express specific desired behaviors. Outcome evaluation of stewardship education programs should include measurements of program participant behavior after it is clearly demonstrated that program design, implementation, and longevity are sufficient to expect particular behavioral changes.

Although behavioral assessment provides the best information about achievement of behavioral program goals, it is not always appropriate or practical to measure changes in participant behavior (for example, some types of desired behavior change may not be expressed until years after programmatic intervention). Early outcome evaluation should focus on attitude research as a key to understanding whether progress is being made toward laying the groundwork for behavior change in program participants. For purposes of evaluation, the researcher should take an approach that uses a comprehensive definition of attitudes, such as that developed by Fishbein and Ajzen (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980). Changes in the cognitive, affective, and conative components of attitudes should all be explored. In other words, evaluation should examine outcomes such as change in knowledge, understanding, opinions, motivations, and behavioral intent.

The relationship between attitudes and behavior is complex and evaluations must be designed and interpreted carefully to provide useful insights on the likelihood of desired behavior changes in program participants. However, recent research has shown that attitude research can help us understand more about the potential influences of programs on behavior if the evaluator takes care to consider the potential influence of an identified set of social, psychological, and situational variables.

As an overall recommendation, the author urges stewardship education professionals to take a comprehensive approach to evaluation. That is, detailed formative evaluation should precede any summative assessments. A comprehensive approach allows one to answer four questions: 1) Was the underlying program model faulty? 2) Was the implementation of the program model appropriate and carried out as prescribed? 3) Were expectations of outcomes/impacts unrealistic, therefore unattainable? 4) Was the evaluation itself adequate in terms of methods, impact indicators examined, people contacted, etc. to obtain valid, reliable, and programmatically meaningful information? (Decker 1988:19). A technique known as evaluability assessment was recommended to address parts 1-3 of comprehensive evaluation. Several common deficiencies in stewardship program evaluations were described. To address these deficiencies the author recommends that leaders in this field: 1) develop better indicators of program outcomes (e.g., knowledge gains, attitude change, behavioral intent, behavioral expression); and 2) take steps to establish a few long-term research projects designed explicitly to explore research questions utilizing experimental or quasi-experimental research designs.

Future Research

The following are recommendations for a research agenda that can advance design and implementation of stewardship education programs by filling gaps in information about best practices. These recommendations represent the author's sense of the type of research needed to address the highest priority information needs. The recommendations offered here are broad in scope and include some methodological consideration that the author believes will advance understanding of best practices. They reiterate points made earlier.

- Conduct a national assessment to identify long-term stewardship programs that: address entry-level, ownership-level, and empowerment-level variables;

- include social support and apprenticeship experiences for learners and integrate formal and nonformal learning situations. Programs identified should serve as the focus of additional research.
- Conduct detailed evaluability assessments of programs identified in the process described above. Programs that are found to have a high level of implementation fidelity should be selected for long-term outcome evaluation.
- Create program treatment groups solely for research purposes (i.e., create groups specifically for research purposes). Randomly assign program participants to treatment groups and create conditions under which the researcher can manipulate the characteristics of the program for each treatment group. Use experimental or quasi-experimental study designs to explore the relationship between program elements and desired program outcomes.
- Design studies that utilize behavioral observation and authentic assessment to measure changes in learner knowledge, attitudes, and behaviors.
- Create longitudinal studies to track changes over time for cohorts of program participants.
- Conduct basic research to develop valid and reliable indicators of program influences on attitudes, motivations, perceived stewardship responsibilities, behavioral intentions, and behaviors.
- Employ social psychological and educational theory to guide research on the relationship between knowledge, attitudes, intentions, and environmentally responsible behavior.
- Conduct additional research on incentives and disincentives to engage in stewardship behaviors.
- Use longitudinal studies to examine how stewardship apprenticeship experiences influence expression of environmentally responsible behaviors.

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